there are three errors; p. 147, line 7, dele "is *r*," there are two other errors on this page; p. 187 we have a vague reference to Boole's Differential Equations, and a misprint lower down; there are other minor errors easily detected, but when correcting pp. 114 to 116, somebody must have had his eyes shut at times or he would not have passed such a number of clerical errors.

In IV. we have a fresh work, well adapted for the higher forms in schools, though the examples are in some cases difficult. There are good notes, and the whole book may be recommended to students reading for scholarship or for college terminal examinations. We could put our finger upon many a mistake easily detected by an advanced student, so that we should advise junior pupils not to spend too long a time upon the questions if they do not succeed in getting the same answer as is given in the text. In making this statement we are bound to say that the number of mistakes seems to be no greater than is almost inevitable in a first edition.

The manual V. contains "more than 160 deductions which have been set at public examinations, worked out in full as examples, together with a collection of specimen examination papers, which have been set at the examinations, Cambridge Mathematical Tripos, London University Matriculation, &c." This fuller title gives a good idea of the scope of the work: it aims at doing for junior students what is done for higher students by McDowell's exercises on Euclid and in Modern Geometry. We have only been able to look into the book casually; we have found the parts so examined correct and put in such a way that a lad acquainted with the text of Euclid ought to have no difficulty in following the proofs here given. The student has to draw his own figures. The printing is good and so done as to assist the reader in his work. From the initials attached to the preface we should infer that the compiler is Mr. A. T. Fisher, whose "Book of Algebra" in the same series we commended, at the time of its publication, in these columns.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Spectrum of Brorsen's Comet

I HAVE to thank Dr. Marshall Watts for having called attention to a point of some interest with regard to the spectra of comets, viz., which of the carbon spectra agrees with the cometary spectrum? In the case of Brorsen's comet the most important question was, whether the spectrum differed *largely* from that of other comets, as found by Dr. Huggins in 1868, and not having much leisure at the time of writing to examine the question of the different spectra of carbon, I overlooked the circumstance that the comparison spectrum used by Prof. Young was the first or flame spectrum of carbon. The difference, however, in the positions of the bands in the two spectra of carbon is a quantity which it is not very easy to answer for in the case of a faint cometary spectrum, and it is but a small fraction (less than one-fourth) of the discordance between Dr. Huggins's measures in 1868 and those made at the present return of the comet.

In the comparisons made at Greenwich the induction-spark (without Leyden jars) was taken in a vacuum-tube containing alcohol vapour at a pressure of 1·2 mm., and the green comet-band was compared with this spectrum exactly in the manner described by Dr. Watts, though practical difficulties of manipulation prevented our making comparisons with the flame spectrum, as I wished. In fact the awkward position of the spectroscope in observing the comet below the pole made the observations extremely difficult, and caused great loss of time, so that the results are not so numerous as they would otherwise have been. On April 17 I used a micrometer eye-piece, with a movable bar, the breadth of which corresponded to 30 tenth-metres, whilst the slit was of such a width that the line with which the band in the alcohol-spectrum commences was 45 tenth-metres broad. The bar was brought up from the blue end so as just not to hide the less refrangible edge of the comet-band; the spectrum from the alcohol vacuum-tube was then flashed in, and the less refrangible edge of the carbon-band was found to be just visible beyond the bar. Several comparisons were made in this way, and I estimated that the uncertainty in the determination of the coincidence between the less refrangible edges of the comet and carbon-bands was but a small fraction of the breadth of the bar (30 tenth-metres). I did not obtain any micrometer readings. On April 19 and 28 Mr. Maunder, from readings with a bright-line micrometer, found for the position of the bright edge of the comet-band in the green, compared with the centre of the line at the edge of the alcohol-band (wave-length, 5198·3):—

	Comet-band. Tenth-metres.	Wave-length inferred.	Width of Slit.
April 19	0·5 to blue	5190	0·009 in. = 16 tenth-metres.
28	4·5 to red	5191	0·013 ,, = 24 ,,

In computing the wave-length of the bright edge of the comet-band, half the breadth of the alcohol-line (= width of slit) has been applied. In a similar manner the wave-length of the bright edge of the comet-band in the yellow was found to be 2·4 tenth-metres to the red of the edge of the alcohol-band at 5610·5, or at 5580, allowing for the width of the slit, which was 0·033 in. or 65 tenth-metres. The position of the blue band was estimated to be *approximately* coincident with the blue band of alcohol at 4834, but this determination is very rough indeed. The dispersion used was that of one "half-prism," viz., 20° from A to H, equivalent to four flint prisms of 60° with a magnifying power of twelve. In my former letter I, by mistake, gave the dispersion as equivalent to two prisms only, instead of four. The high dispersion used is of course an important element in estimating the accuracy of the determination, and on comparing afterwards the flame and vacuum-tube spectra of carbon with the width of slit and other conditions of observation the same as on April 17 and 19, I found the two bands so widely separated that it appeared impossible to mistake one for the other in estimating a coincidence. I may add that the spectrum of Coggia's comet also was found to be identical with the second spectrum of carbon. With regard to Dr. Huggins's observations of Comet II. 1868, and Coggia's comet, Dr. Watts does not give his reasons for the assertion that the comparison spectrum was the first spectrum of carbon. According to the diagram given by Dr. Huggins, the spectrum in olefiant gas is distinctly different from that in olive oil, which I presume is the first spectrum, and the comet-spectrum agrees with the former. As far as I can judge, this is the spectrum which we have obtained in vacuum-tubes, whether they contain alcohol, carbon-oxide, carbon-dioxide, or olefiant gas. I do not wish to enter on the question as to whether the differences in the carbon-spectra result from differences of chemical composition or of molecular condition depending on temperature, though I may remark that the same vacuum-tube gives quite a different spectrum when Leyden jars are introduced into the circuit.

W. H. M. CHRISTIE

Royal Observatory, Greenwich, May 17

End-on Tubes, brought to Bear upon the Carbon and Carbo-Hydrogen Question

IN NATURE, vol. xx. p. 28, there is an important paper by Dr. Marshall Watts, touching certain recent observations of carbon spectra so-called, which seems to offer an excellent opportunity for clearing up certain long-disputed points in spectroscopy, and to the satisfaction, I hope, of every one.

Firstly, the Doctor alludes to the recent happy case of Prof. Young, of Princeton, U.S., having last month compared the green band of Brorsen's comet with the green band of a Bunsen gas burner, and found them identical in spectrum place, thereby

bringing the said Brorsen's comet into line with most other comets, as to possessing both that band and material.

Secondly, Dr. Watts alludes to Mr. Christie, of the Royal Observatory, Greenwich, having also recently observed the spectrum of the same comet, and stated that he had thereby found the *same* result as Prof. Young. But the Doctor implies there must be some mistake therein, because—what Mr. Christie compared the sharp edge of the comet's green band, with, and found it coincident, was not the Bunsen gas burner's green band, but that of an alcohol vacuum tube illumined by electric spark; and this latter green band, he says, is in an absolutely different spectrum-place to that occupied by the coal-gas burner's green band.

The first answer here, is both pleasant and simple. I know perfectly well what it is the Doctor alludes to, as being visible in the alcohol vacuum tube, but would beg to remind an accomplished laboratory worker that it is so close in spectral place to the coal-gas flame's green band, that in any spectroscope of very small dispersion, and when the subject is seen only faintly and at intervals in a difficult astronomical observation, such minute difference of place might well be disregarded in comparison with the enormous difference or anomaly of an older, almost historic, record, whose large discrepance, eight times larger than the other difference, was really the thing which both Mr. Christie and Prof. Young had before them, either to prove or disprove. And as they have now each of them independently assured us, by special observations at the end of a telescope in the cold night air, that the enormous anomaly suspected of old no longer exists—they both deserve our best thanks.

But next comes, for those who work in-doors with brighter lights and more powerful spectroscopes, the second part of the answer, with a proof that Mr. Christie, after all, may not have used a differently placed reference to Prof. Young's, even in the least degree, because, *besides* what Dr. Marshall Watts says very truly, there is in the spectrum of an alcohol vacuum tube electrically illumined, there is *also* a something else which he either has not seen, or has not yet recognised as such, but which is the very identical green band of the coal-gas flame in open air.

The special green band which the Doctor *has* seen and recognised in an alcohol vacuum tube is to be seen equally in vacuum tubes of all gases containing carbon in any combination, and is therefore abundantly visible in tubes of carbon monoxide, carbon dioxide, and cyanogen. This, too, is the spectrum which he calls the "Carbon spectrum No. 2," but which I call simply the spectrum of carbon; a spectrum which no one has yet found in any common candle flame, coal-gas flame, or comet in the sky; and it requires apparently the ecstatic heating of the electric spark for its smallest development.

But the other green band, which I shall presently prove is also in an alcohol vacuum tube, though the Doctor may not have recognised it there, he has seen abundantly elsewhere, for it is found in the blue base of every candle, lamp, or coal-gas flame, and he has given the spectrum place of the beginning of it with exceeding accuracy. In fact, the only unhappy thing is, that he will look upon it as pure carbon, calling it the "Carbon spectrum No. 1," when it is so evidently the compound "carbo-hydrogen;" for with my new end-on tubes, while I do *not* see *this* green band in vacua of either carbo-oxygen or carbo-nitrogen (unless ultra-faintly as a trace of impurity), I do see it, and most brilliantly, in tubes of such rich carbo-hydrogens as alcohol and olefiant gas.

Now it is not a little singular as a coincidence merely, that I was actually engaged only yesterday, after an interval of several years, in pointing out to my friend Prof. Swan, of St. Andrews, the existence of "his" carbo-hydrogen blow-pipe flame's lines of its green band, projected upon, and differently placed from, the true elemental carbon green band ot an alcohol vacuum tube, electrically illumined; and we proceeded thus to test the identity of what I called "his" flame lines, by a close proof of place, which is everything in spectroscopy.

A coal-gas and air blow-pipe flame, end-on, was set up before the spectroscope on one side of the table, and on the other side an alcohol vacuum tube, illuminated by 1-inch sparks from a small coil, and viewed also end-on. The spectroscope could be rotated easily in azimuth by endless screw motion, so as to look with its gathering telescope first into the tube, then into the flame, and then again into the tube. The prism train had the large dispersion of 33° between A and H, the telescope a magnifying power of 10, and its pointer was one of Mr. Hilger's latest and most refined steel wedges of almost infinite sharpness.

The slit was made exceedingly narrow, the definition in the centre of the field was super-excellent, and then Prof. Swan micrometrically bisected a certain thin but exceedingly bright line, which looked like an anomaly on the surface, and far within the least refracted edge of the elemental carbon green band of the alcohol tube, and clamped the pointer in that exact spectrum place.

I then rotated the whole instrument round to the blow-pipe flame, and asked him "What is the pointer on now?"

"On the first and brightest line of the blow-pipe flame's green band," he answered, "Alexander Herschel's green giant of carbo-hydrogen, and it is admirably bisected too."

We next rotated back to the alcohol tube, and found the pointer still accurately bisecting that bright line present there, which was a total anomaly in a pure carbon spectrum, though perfectly agreeable to what Prof. Swan wrote of the compound carbo-hydrogen's flame spectrum, twenty-three years ago. Most opportunely present also in that tube, for it enabled Mr. Christie to compare Brorsen's comet with the same identical reference as that used by Prof. Young, though employing an alcohol spark spectrum, and not a gas-burner.

The second line of the blow-pipe flame's green band, though much fainter, is also distinctly seen in the end-on view of the alcohol tube's spectrum, and answers perfectly to a similar test for place as the first line. Wherefore, I would beg to ask, how can I hold any other view than that carbon, as a pure chemical element, and the most refractory that is known, has no spectrum short of electric spark temperature; and what it then shows is, to exact measurement with large dispersion, a perfectly different spectrum to that of the compound gas, carbo-hydrogen; which compound gas, while still existing to some extent in the electric spark tubes, begins its spectral manifestations in the very moderate temperature of merely a farthing tallow candle: a matter to be duly considered in studying the physical condition of comets, which do not show any spectrum (or, for small and "uncondensed" sparks, we may say *the* spectrum) of pure elemental carbon.

PIAZZI SMYTH

Edinburgh, May 9

The Victoria University

IN the article on the Victoria University in the last number of NATURE, I observe some inaccurate statements regarding the Queen's University in Ireland.

In the first place there are not *four* colleges, but *three*. Next there are no *degree* examinations in any college, but all are conducted in Dublin by the examiners of the university, who, for the most part, are also professors in the colleges; but there are some examiners who are not professors, and also some professors who are not examiners.

A. J. C. ALLEN

Peterhouse, Cambridge

Maps of Old Geological Coast-lines, &c., &c.

I NOTICE in Woodward's "Manual of the Mollusca," when speaking of the "Boundaries of Natural History Provinces," p. 352, the following:—

"The seas are divided by continents and influenced by the physical character of coast-lines, by climates, and currents."

May not the occurrence of different species in different parts of contemporaneous strata help to determine the positions of land and water, &c., in past geological ages?

W. W.

Cambridge

[In reply to "W. W.'s" interrogatory, "May not the occurrence of different species in different parts of contemporaneous strata help to determine the positions of land and water, &c., in past geological ages?" we would say, Yes, most certainly; and it is not only by recording the occurrence of *different species*, probably peculiar to different zones of depth, that geologists have long tried to mark out old sea-beds, but more especially by tracing carefully *the occurrence* of the *same species* along extended lines of formations, they have attempted to map out old geological coast-lines. Much has been done in this direction by Godwin-Austen, Forbes, Quenstedt, Oppel, Waagen, Hebert, Oswald Heer, and many others; but much more remains to be accomplished, and "W. W." cannot do better than take up some such line of inquiry for his summer vacations. How much good field-work might be done in three months' holidays in, say, three successive years, with a knapsack on one's back and a hammer in one's hand, let the admirable papers by Dr. Chas. Barrois of Lille tell!—H. W.]